RAP Figuring slumped mirrors to remove mid-spatial frequency errors, Phase I

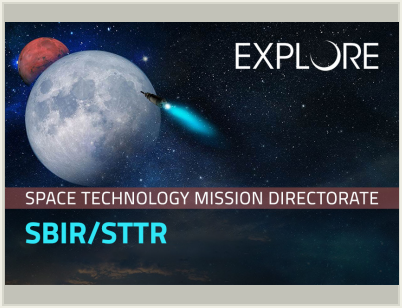
Completed Technology Project (2009 - 2009)

Project Introduction

Future X-ray telescopes require significant amounts of optical area. To accommodate this in a grazing incidence design, extremely thin mirrors are formed in concentric shell configurations. A slumping technique has been demonstrated with such thin, lightweight shells. However, the optical surface is found to contain a significant amount of mid-spatial frequency errors. It is proposed to demonstrate a sub-aperture figuring technique that does not impart mid-spatial frequencies to the optical substrate geometries planned for integration into next-generation X-ray telescopes. Reactive Atom Plasma (RAP) is a sub-aperture, atmospheric pressure, non-contact figuring technology that relies on a deterministic gas-phase etching of the optical surface with high material removal rates. RAP has already been demonstrated as a very credible approach for fabricating the lightweight wedges required for the assembly of such mirrors. RAP is especially suitable for damage-free processing of extremely lightweight mirrors given the non-contact operation, and its ability to ameliorate sub-surface damage. The tool footprint is a Gaussian and hence has a limited capability to both impart mid-spatial errors, as well as to fix them. In phase 1, we plan on demonstrating the ability of the RAP process to impart minimal mid-spatial errors into the optical surface while a figuring demonstration using adjustable footprints is planned for phase 2.

Anticipated Benefits

Potential NASA Commercial Applications: Other optics applications involve lithography, surveillance tracking and fire-control systems with various commercial and DoD agencies. Making precision surfaces with a high aspect ratio is a common problem across optics, semiconductors, compound semiconductors, photo-voltaics etc. The high aspect ratio results from a need to reduce mass (as in the case of lightweight mirrors), improve device performance/packaging (as in semiconductors), decrease costs (as in photo-voltaics). The methods developed in Phase 1 can be applied to the rapid manufacturing of such surfaces in these other areas. RAPT Industries, Inc. has already commercialized the edge cleaning of semi-conductor wafers through a licensing arrangement with Accretech, USA.



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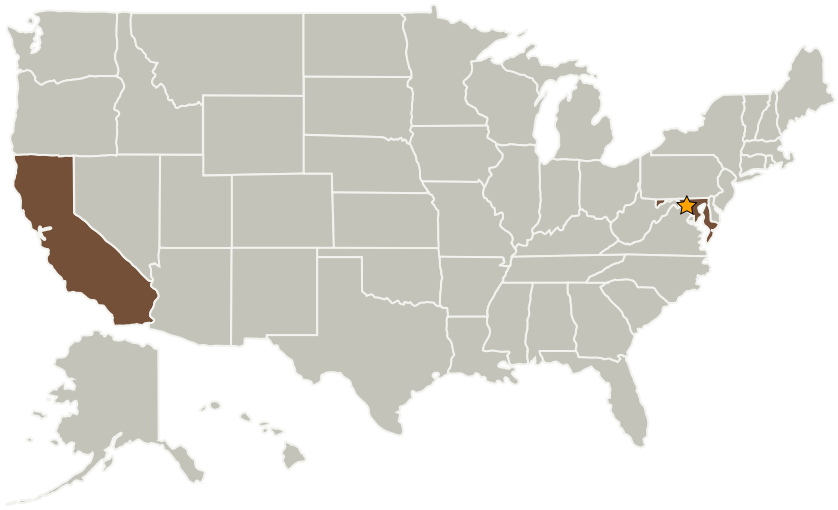
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
RAPT Industries, Inc.	Supporting Organization	Industry	Fremont, California

Primary U.S. Work Locations	
California	Maryland

Project Transitions

January 2009: Project Start

July 2009: Closed out

Closeout Summary: RAP Figuring slumped mirrors to remove mid-spatial frequency errors, Phase I Project Image

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

Petar Arsenovic

Principal Investigator:

Pradeep K Subrahmanyan

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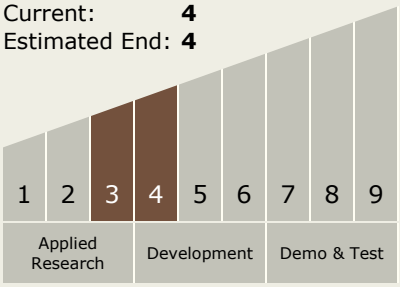
Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.1 Mirror Systems